PROJECT-X1 xx1 Requirements Analysis Report

July 2004

Table of Contents

1 Executive Summary 2
2 Analysis Scope 3
3 Analysis Methodology 4
4 Analysis Findings and Conclusions 6
4.1 Requirement Documentation Quality 6
4.2 System Needs 6
4.3 Individual Requirement Quality 7
4.4 Others 7
5 Recommendations 8
Appendix A: xx1 Requirements Issue Details 9
Appendix B: PITS Issues 10
6 Acronyms 11

Tables

Table 2-1 – Analysis Documentation 3
Table 2-2 – Reference Documentation 3
Table 3-1 – xx1 Requirements Analysis Activities 4
Table 3-2 – Analysis Tools 5
Table 5-1 – IV&V Recommendations 8
Table 5-2 – Accepted Project Actions 8
Table 5-3 – IV&V Actions 8

1 Executive Summary

The Independent Verification & Validation (IV&V) Team has completed an analysis of the xx1 Software requirements for the PROJECT-X1 project. The purpose of this analysis was to ensure the xx1 software requirements provide a sound foundation for subsequent design, implementation and verification activities. Findings and conclusions are summarized below and additional detail for each is provided in Section 4.

An analysis of the April 15, 2003 revision of the xx1 Software Requirements Specification (SRS) was first performed and then updated to reflect a partial release of the xx1 SRS, released prior to the xx1 Preliminary design Review (PDR). Significant findings resulting from this analysis include:

- Although the xx1 SRS is not organized according to NASA or industry standards, it does, when combined with other supporting documents, contain the information necessary to specify the requirements for the xx1 software.
- The xx1 software requirements are adequate to meet system needs.
- The general quality of the individual xx1 requirements is good and should establish a sound foundation for design, implementation and verification activities.
- Though the traceability documentation is incomplete, all of the xx1 software requirements trace back to a system level requirement.
- Based upon the similarities with the PROJECT-X2 xx2 software and the current utilization margins, hardware utilization should present no problems.

Overall, the IV&V Team found the xx1 requirements to be adequate for development with only a few documented exceptions. Four Technical Issue Memoranda (TIMs) were opened and have been communicated to the Project. The Project has accepted all of these TIMs and is working the issues to closure.

2 Analysis Scope

The purpose of this report is to describe the analysis methodology, findings and recommendations resulting from IV&V analysis of the xx1 requirements for the PROJECT-X1 Project. Each of the requirements contained in Revision 1.0 of the xx1 SRS were included in this analysis.

The documents identified in Table 2-1 were reviewed during the course of this analysis.

Document Title	Document Number	Date
xx1 Software Requirements	Draft	04/15/2003
xx1 Software Requirements	Revision 1.0	9/22/2003

Table 2-1 – Analysis Documentation

The documents identified in Table 2-2 were referenced during the course of this analysis.

Document Title	Document Number	Date
PROJECT-X1 System Requirements Document	0001-11	03/15/2003
PROJECT-X1 Spacecraft Requirements Document	0001-15	03/12/2003
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Table 2-2 – Reference Documentation

3 Analysis Methodology

This section describes the approach and tools used to perform the requirements analysis activities provided for in the IV&V PROJECT-X1 Project Plan. The activities that are applicable to xx1, based on IV&V Analysis Levels (IALs), are shown in Table 3-1. This table also identifies the section in this report where the associated findings and conclusions are discussed.

Requirements Analysis Activity	Findings Section
Verify documentation meets intended purpose, has appropriate detail and all necessary elements	4.1
Validate ability of requirements to meet system needs	4.2
--	4.3
--	4.4
	--

Table 3-1 – xx1 Requirements Analysis Activities

Detailed requirements evaluation criteria are provided in the IV&V PROJECT-X1 Requirements Analysis Guidelines and will not be provided here. However, it is appropriate to generally describe how the requirements analysis was performed. For activities that involve analysis of individual requirements, a spreadsheet was developed to capture analysis findings and comments as they were generated. The spreadsheet was initially populated with the following items:

- Requirement Unique Identifier
- Section Number
- Title
- Requirement Text

As the analysis proceeded, the following results were captured:

- Is the requirement traceable to a parent? (Yes/No)
- If Yes, Parent Requirement Unique Identifier
- Is the requirement Correct/Complete/Consistent/Unambiguous/Testable? (Yes/No)
- If No, comments on requirement deficiency

This arrangement facilitates capture, organization and tracking of findings and comments. It also allows for the development of metrics (e.g. traceability errors, requirement quality errors, etc). The spreadsheet will be expanded as analysis proceeds into other development phases and will eventually collect all requirement specific information

pertaining to parent traceability, requirement quality and traceability to the verification program.

It should be noted that because complete, detailed parent/child traceability information was unavailable, it was necessary to establish traceability from scratch for much of this analysis. This was accomplished by reviewing the parent specifications for requirements that apply to the xx1 software. The xx1 requirements were then linked to these parents as appropriate. In establishing this trace, considerable latitude was allowed for derivation of children requirements from the set of higher-level requirements. Essentially, if the software requirement is reasonable and could be even loosely connected to a more general requirement, then it was considered traceable. The goal was to identify software requirements that were completely out-of-family and clearly not provided for in the higher-level specifications. A downward traceability was also performed to ensure that all relevant parent requirements were adequately captured in the xx1 Software specification.

The tools identified in Table 3-2 were used during the course of this analysis.

Tool	Use
DOORS	Used to extract Mission and Spacecraft Requirements
PITS	Used to capture issues identified during this analysis
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Table 3-2 – Analysis Tools

4 Analysis Findings and Conclusions

This section contains findings and conclusions resulting from each of the activities identified in Table 3-1.

4.1 Requirement Documentation Quality

Discussion

The IV&V Team evaluated the xx1 SRS relative to information that is typically provided in a requirements document (as detailed in Section 5 of IEEE Std 830-1998). xx1 Software Requirements (draft), generated on April 15, 2003 was used during the preliminary analysis. The analysis results were then updated to reflect the changes made in Revision 1.0, released prior to the xx1 PDR held on October 21, 2003.

Findings

- Individual elements of xx1 SRS are clearly titled (marked with unique identifiers) and required elements are signified by the use of "shall".
- Qualification methods are specified for each requirement.
- Interface descriptions are not contained in the requirements document, but are maintained in separate Interface Control Documents (ICD's).
- The software requirements (Section 2) provide a detailed and complete specification of the xx1 Software when combined with the separate ICD's. The Overview (Section 1) though terse, is adequate.
- Traceability to system level requirements is not contained in the xx1 SRS, nor is it contained in the DOORS database. This deficiency has been documented in PITS.

Conclusions

Although the xx1 SRS is not organized according to NASA or industry standards, it does, when combined with other supporting documents contain the necessary information to specify the requirements for the xx1 software.

4.2 System Needs

Discussion

This analysis addresses whether the xx1 software requirements sufficiently meet the system needs as defined in the PROJECT-X1 System Requirements Document. This analysis is primarily concerned with the traceability of parent level requirements to the xx1 software requirements. Given that higher-level requirements adequately capture the needs of the xx1 software, and that those requirements properly flow to lower-level derived requirements, the software requirements should capture the system needs.

Findings

- The PROJECT-X1 Spacecraft Requirements Document appears to be the primary parental requirements document for the xx1 SRS, though the SRS makes no reference to it.
- All of the requirements in the Spacecraft Requirements document that are specifically allocated to xx1 code were found to be traceable to the xx1 SRS.
- General command and telemetry requirements were also found to be traceable.

Conclusions

The xx1 software requirements are adequate to meet system needs.

4.3 Individual Requirement Quality

Discussion

Each xx1 Software requirement was evaluated to determine whether it is correct, complete, consistent, unambiguous and testable.

Findings

- Most all of the requirements were acceptable with regard to the quality criteria that were applied. Of the 202 "shall" requirements in the April revision of the xx1 Requirements Document, 182 (90%) were judged to be acceptable as written. As of the September revision, 221 of 210 (95%) were judged to be acceptable as written.
- Issues, questions and comments, were submitted to NASA Center X for review and response. All of the submitted issues have been accepted by the Project.
- Most of the issues are due to ambiguities in the wording of requirements. The details of these issues are provided in Appendix A.

Conclusions

The general quality of the individual Xx1 requirements is good and should establish a sound foundation for design, implementation and verification activities.

4.4 Others

Discussion

Findings

Conclusions

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5 Recommendations

Table 5-1 contains a list of recommendations based upon the findings discussed in this report. The findings of Section 4 that required Project attention were captured in the IV&V PITS database and were communicated to the Project.

#	Recommendation	Benefit
1	Implement accepted actions based upon the findings resulting from this analysis. These actions are summarized below in Tables 5-2 and 5-3.	The completion of the actions will improve the quality and completeness of the xx1 requirements and ensure proper traceability to system level documentation.
-	-	-

Table 5-1 – IV&V Recommendations

#	Project Action
1	Complete the traceability documentation …
-	-

Table 5-2 – Accepted Project Actions

#	IV&V Action
1	Provide the results of the IV&V trace-back of software requirements ..
-	-

Table 5-3 – IV&V Actions

Appendix A: xx1 Requirements Issue Details

ID	Section	Title	Discussion
-	-	Short Title	**IV&V:** Detailed description of the issue goes here **Project Response:** Status goes here
-	-	-	**-**

Appendix B: PITS Issues

This appendix summarizes the Project Issue Tracking System (PITS) Technical Issue Memoranda (TIMs) opened, closed, and monitored by the IV&V Team during the analysis.

Issue Summary:

- x Total TIM(s)
- x TIM(s) Open with Action Taken
- x TIM(s) Closed
- x TIM(s) Close with Concerns
- x TIM(s) Withdrawn

TIM	Severity	Subject	Status
--	-	Incorrect Document References in xx1 SRS	Closed
-	-	-	-

6 Acronyms

C&DH	Command and Data Handling
CARA	Criticality Analysis and Risk Assessment
CDR	Critical Design Review
CPU	Central Processing Unit
IAL	IV&V Analysis Level
ICD	Interface Control Document
IV&V	Independent Verification and Validation
NASA	National Aeronautics and Space Administration
PITS	Project Issue Tracking System
QMS	Quality Management System
RAM	Random Access Memory
SRS	Software Requirements Specification
TIM	Technical Issue Memorandum